Center Innovation Fund: GSFC CIF

Precision Alignment Determination and Control System for a Precision Formation Flying Distributed Spacecraft Mission (DSM-PFF)

Completed Technology Project (2016 - 2017)

Project Introduction

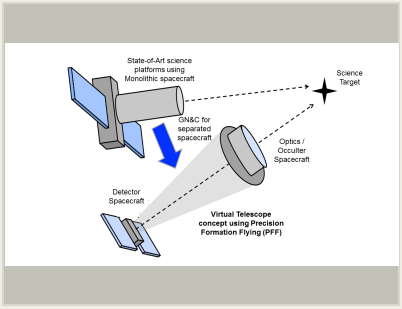
Many proposed science missions use separated optics and detectors on free-flying platforms, maintained in very precise alignment to form a new type of science instrument using precision formation flying (PFF). We plan to develop and validate a guidance, navigation, and control (GN&C) system for the precise inertial alignment control needed for this type of dual-platform distributed spacecraft mission. This project will develop a highly precise, scalable GN&C system architecture to achieve the challenging inertial alignment goals for this unique type of PFF. A complete GN&C system for demonstration of the acquisition and precision inertial alignment will be developed using previously developed IRAD GN&C analysis tools.

The objective of this project is to develop and validate a complete scalable GN&C system for a precision formation flying (PFF) distributed spacecraft mission (DSM) design reference Mission (DRM). We will develop Guidance, Navigation, and Control (GN&C) system component requirements, algorithms, and software for the precise determination and control of an actively controlled spacecraft to meet the formation alignment specifications. Our project will specifically address the technology gap of the systems needed to achieve these DRM-PFF formation alignment specifications.

The navigation system development will incorporate various proposed relative and inertial alignment measurement components into a complete system architecture for overall platform position and attitude state estimation to meet alignment knowledge requirements. Our team will work closely with other IRAD teams developing component technologies to refine system design and component requirements to meet our objectives. This analysis will lead to a complete system navigation filter design and analysis.

We will develop an end-to-end alignment control and disturbance isolation system based on DRM-PFF specifications. System component architectures and component specifications will be developed considering performance that can be obtained from technologies under development and available in the near term for utilization on proposed missions. A complete GN&C system will be analyzed, verified, and validated in a Matlab/Simulink high fidelity simulation. This effort will focus of verifying system performance and operational strategies needed to demonstrate end-to-end GN&C performance and robustness. Our work will focus on development, verification, and validation of an end-to-end GN&C system to a high level of maturity that can be included in future proposals for technology demonstration and/or science missions.

A secondary objective will be to develop specifications and prototype demonstration hardware for an ultra-precise stellar camera system for inertial alignment measurements to achieve high precision inertial alignment goals of the DRM-PFF. There are many options for inertial alignment using commercial-off-the-shelf (COTS) star trackers. But, these are limited to arc-sec level



Advances in GN&C for Precision Formation Flying

Table of Contents

Precision Alignment Determination and Control System for a Precision Formation Flying Distributed Spacecraft Mission (DSM-PFF)

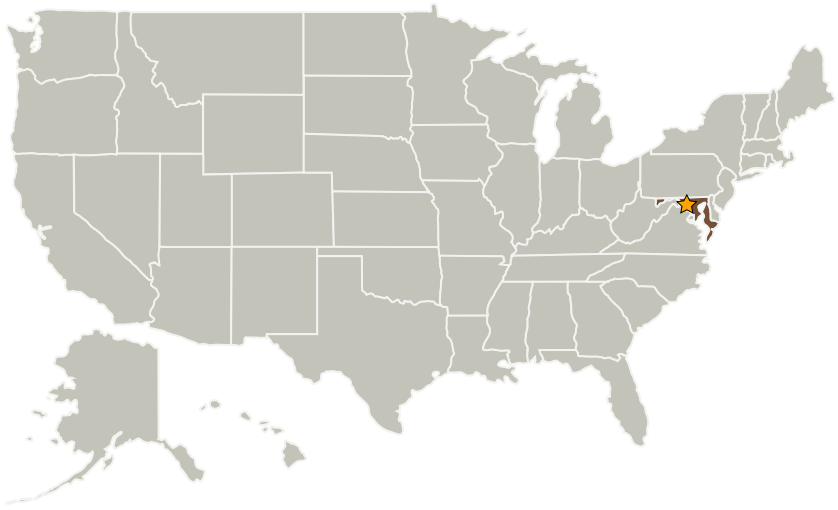
Completed Technology Project (2016 - 2017)

inertial performance. This effort will focus development of an alignment camera system with the goal of milli-arc-sec level performance with size, weight and power (SWaP) that are typical for spacecraft bus components.

Anticipated Benefits

The navigation and control system design and analysis tool will be used for development and technical evaluation of precision formation flying (PFF) system architectures to support proposed PFF science missions. The precision guide star alignment sensor will provide necessary inertial alignment measurements for many PFF missions.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Innovation Fund: GSFC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Peter M Hughes

Project Managers:

Jason W Mitchell
Timothy D Beach

Principal Investigator:

Philip C Calhoun

Center Innovation Fund: GSFC CIF

Precision Alignment Determination and Control System for a Precision Formation Flying Distributed Spacecraft Mission (DSM-PFF)

Completed Technology Project (2016 - 2017)

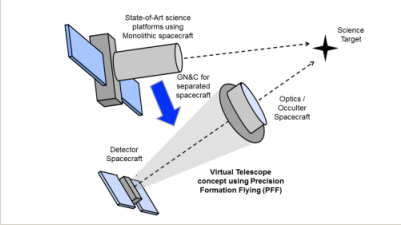
Project Transitions

October 2016: Project Start

October 2017: Closed out

Closeout Summary: The purpose of the Goddard Space Flight Center's Internal Research and Development (IRAD) program is to support new technology development and to address scientific challenges. Each year, Principal Investigators (PIs) submit IRAD proposals and compete for funding for their development projects. Goddard's IRAD program supports eight Lines of Business: Astrophysics; Communications and Navigation; Cross-Cutting Technology and Capabilities; Earth Science; Heliophysics; Planetary Science; Science Small Satellites Technology; and Suborbital Platforms and Range Services.Task progress is evaluated twice a year at the Mid-term IRAD review and the end of the year. When the funding period has ended, the PIs compete again for IRAD funding or seek new sources of development and research funding or agree to external partnerships and collaborations. In some cases, when the development work has reached the appropriate Technology Readiness Level (TRL) level, the product is integrated into an actual NASA mission or used to support other government agencies. The technology may also be licensed out to the industry.The completion of a project does not necessarily indicate that the development work has stopped. The work could potentially continue in the future as a follow-on IRAD; or used in collaboration or partnership with Academia, Industry and other Government Agencies.If you are interested in partnering with NASA, see the TechPort Partnerships documentation available on the TechPort Help tab. http://techport.nasa.gov/help

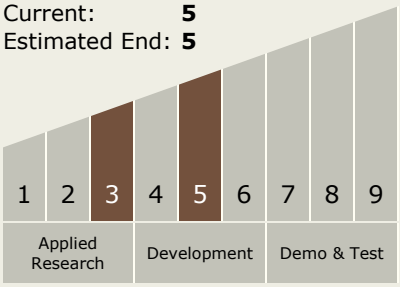
Images



Advances in GN&C for Precision Formation Flying
Advances in GN&C for Precision Formation Flying
(https://techport.nasa.gov/image/24486)

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.2 Structures
    - TX12.2.5 Innovative, Multifunctional Concepts

Target Destinations

The Sun, Outside the Solar System